Refer to: Fitzgerald FT: Hypoglycemia and accidental hypothermia in an alcoholic population. West J Med 133:105-107, Aug 1980

Hypoglycemia and Accidental Hypothermia in an Alcoholic Population

FAITH T. FITZGERALD, MD, *Ann Arbor, Michigan*

Hypoglycemia is but one of a number of causes of hypothermia, but is important to keep in mind as a possible precipitating or concurrent event even in those cases in which there are other obvious explanations for decreased body temperature (exposure, alcoholism, starvation, sepsis or hypothyroidism). Hypoglycemia may occur in as many as 40 percent of very cold patients, and be clinically unrecognized because symptoms are masked by the hypothermia itself. Although serum glucose levels are depressed, a cold-induced renal tubular glycosuria may occur. Glucose in the urine, therefore, cannot be used as assurance of hyperglycemia in a hypothermic patient. And, although cold protects against serious end organ damage from hypoglycemia by decreasing tissue metabolic need for glucose, a serum specimen should be drawn for glucose determination in all hypothermic patients and a 50 percent glucose solution immediately given intravenously. If this is not done, serum glucose levels may plummet as the patient is rewarmed and begins to shiver.

HYPOTHERMIA DURING INSULIN THERAPY and insulin-independent hypoglycemia has been recognized for many years.[1-4] The hypothermia of hypoglycemia is a result of intracellular glucopenia in the hypothalamus, probably mediated by an alteration of neurohumoral controls.[5] Teleologically, it seems a protective *turning down* of body temperature, and therefore of metabolic rate, in the face of inadequate fuel supply.

Hypothermia may also cause hypoglycemia. In cases of prolonged hypothermia[6] and in starved hypothermic persons,[7] low serum glucose values are usual. In addition, a cold-induced renal tubular glycosuria may actually contribute to hypoglycemia by wasting glucose through the kidneys.[7]

Other influences in cases of hypothermia oppose the development of hypoglycemia. Tissue consumption of glucose decreases as temperature falls.[8-13] Decreased pancreatic insulin release,[14-17] decreased tissue sensitivity to insulin,[10] liver dysfunction[8] and cold-induced pancreatitis[18-23] may all contribute to elevation of serum glucose in hypothermic patients.

Excess ingestion of alcohol is a common associate of accidental hypothermia[18,24-28] and alcohol may induce hypoglycemia.[29-31] The case records of 22 hypothermic, predominantly alcoholic patients were obtained from medical records by selecting the diagnostic code for hypothermia. These records were retrospectively reviewed in

From the Department of Internal Medicine, the University of Michigan Medical School, Ann Arbor.

Submitted September 13, 1979.

Reprint requests to: Faith T. Fitzgerald, MD, Director, Inpatient Programs, Dept. of Internal Medicine, University of Michigan Hospital, Ann Arbor, MI 48109

order to study the relationship of hypothermia to glucose levels.

Patients and Methods

The 22 patients (19 men and 3 women) all were admitted by way of the emergency room of the San Francisco General Hospital between 1975 and 1977. All had rectal temperatures no higher than 34.4°C (94°F). All but two were alcoholic. Only one was younger than 50 years. Of the 22 patients, 12 were found indoors, in apartments or hotel rooms.

In all 22 a serum specimen for glucose determination was drawn on entry, before parenteral administration of glucose. The highest serum glucose value was 314 mg per dl in a patient with chronic pancreatitis (case 2). The lowest was 13 mg per dl in an alcoholic patient (case 11). In nine patients (41 percent) serum glucose levels were lower than 50 mg and in five (23 percent) they were higher than 150 mg per dl. Analysis of urine specimens showed three patients to be glycosuric. Of these, two had concurrent serum glucose levels of less than 80 mg per dl. In one patient the urine reaction for glucose was 2+, with a serum glucose value of 18 mg per dl. In the other the urine reaction for glucose was 1+, with a serum glucose level of 76 mg per dl (cases 15 and 6).

Notes in the case records referring to nutritional status were made in only two cases: One man was "debilitated," another "thin." In six patients, however, there were serum albumin values of less than 2.5 grams per dl; it would be difficult to consider a patient with this level of albumin well nourished. Five of these six were hypoglycemic.

In two of the patients a clinical diagnosis of alcoholic pancreatitis was made during the admission for hypothermia. One of these was hyperglycemic (case 1) and one hypoglycemic (case 10). In one patient with insulin-requiring diabetes

TABLE 1.—*Serum and Urine Glucose in Twenty-two Hypothermic Patients*

Case	*Age*	*Sex*	*Temp. F°*	*Diagnosis*	*Serum Glucose mg/dl*	*Urine Glucose (Dipstick)*	*Outcome*
1. ..	51	M	84	ETOH, seizure, pancreatitis, GI bleeding, profound folate deficiency (hematocrit=10%)	157	(−)	Died
2. ..	39	M	87.6	ETOH, seizure, chronic pancreatitis, sepsis, shock, renal failure, arrest	317	2+	Died
3. ..	62	M	80	ETOH, urinary tract infection, hypoxia	85	(−)	Alive
4. ..	55	M	82	ETOH, parietal fracture, epidural hematoma, SIADH	110	(−)	Alive
5. ..	80	M	93	ETOH, ketosis	200	(−)	Alive
6. ..	58	M	85	ETOH, cirrhosis, ascites, liver failure, DIC, cardiopulmonary arrest	76	1+	Died
7. ..	85	M	95	Cancer pancreas, diabetes, respiratory arrest	25	(−)	Died
8. ..	62	M	86	ETOH, Gram-negative sepsis, hypothyroidism	26	(−)	Alive
9. ..	70	M	92	ETOH, hypertension	42	(−)	Alive
10. ..	53	M	92	ETOH, cirrhosis, anemia, GI bleeding, pancreatitis, cardiac arrest	37	(−)	Alive
11. ..	65	M	83	ETOH, Gram-negative sepsis, ATN, pulmonary edema, GI bleeding	13	(−)	Died
12. ..	74	M	88	ETOH, cancer prostate, dementia, GI bleeding	102	(−)	Alive
13. ..	67	M	85	ETOH, Gram-negative sepsis, hypotension	47	(−)	Alive
14. ..	55	M	90	Myxedema, pneumonia	175	(−)	Alive
15. ..	70	F	75	ETOH, ATN, pneumonia	18	2+	Alive
16. ..	68	M	92	ETOH, cirrhosis, hepatoma	112	(−)	Died
17. ..	50+	F	87	ETOH, cirrhosis, ascites	90	(−)	Alive
18. ..	68	M	84	ETOH, dementia, hypothyroidism	40	(−)	Alive
19. ..	62	F	89	ETOH, Gram-negative pneumonia	95	(−)	Alive
20. ..	50+	M	91	ETOH, Wernicke-Korsakoff encephalopathy	175	(−)	Alive
21. ..	59	M	84	ETOH, sepsis, pneumonia	128	(−)	Alive
22. ..	59	M	86	ETOH, Gram-negative sepsis, ATN	35	(−)	Died

ATN = acute tubular necrosis
GI = gastrointestinal
DIC = disseminated intravascular coagulation
SIADH = syndrome of inappropriate antidiuretic hormone
ETOH = alcohol use or alcoholism

and pancreatic carcinoma the serum glucose value was 25 mg per dl (case 7). No other patient was known to have diabetes. Of four patients with cirrhosis of the liver listed as an admission diagnosis, only one was hypoglycemic (case 10), and he had concurrent pancreatitis.

Of the nine hypoglycemic patients, four died (44 percent). There were also four deaths among the remaining 13 patients with serum glucose levels greater than 50 mg per dl.

A listing of admission data, diagnoses, glucose values and outcome is given in Table 1.

Discussion

As may be seen in Table 1, the multiplicity of problems seen in this small series of patients prohibits making valid inferences about the influence of hypoglycemia on morbidity or mortality. It was supposed that some of our hypothermic patients might be hypoglycemic, drawn as they were from a population predisposed to hypoglycemia: malnourished[32,33] alcoholic persons.[29-31] But the fact that 41 percent of our patients were hypoglycemic made this a surprisingly common finding in alcoholic accidental hypothermia. In a study by Weyman and his colleagues[24] of 39 cases of hypothermia—82 percent of which had alcohol listed as a predisposing factor—in only one was the serum glucose level below 50 mg per dl. In our series there was no reliable relationship between depth of hypothermia and serum glucose levels.

In light of these data, all hypothermic patients, unless serum glucose values are known to be normal or high, should receive 50 percent glucose solution intravenously immediately after a serum specimen has been drawn for glucose measurement. Because of hypothermic renal tubular glycosuria, the presence of glucose in the urine of cold patients is no guarantee of elevated levels of serum glucose, and may indeed be contributing to the hypoglycemia of hypothermia.

REFERENCES

1. Cassidy GJ, Dworkin S, Finney WH: Insulin and the mechanism of hibernation. Am J Physiol 73:417-428, 1925

2. Kedes LH, Field JB: Hypothermia—A clue to hypoglycemia. N Engl J Med 271:785-787, 1964

3. Molnar GW, Read RC: Hypoglycemia and body temperature. JAMA 227:916-921, 1974

4. Strauch BS, Felig P, Baxter JD, et al: Hypothermia in hypoglycemia. JAMA 210:345-346, 1969

5. Frienkel N, Metzger BE, Harris E, et al: The hypothermia of hypoglycemia. N Engl J Med 287:841-845, 1972

6. Fisher B, Fedor EJ, Lee SH: Rewarming following hypothermia of two to twelve hours.—II Some metabolic effects. Ann Surg 148:32-43, 1958

7. Blair E: Clinical Hypothermia. New York, McGraw-Hill Book Co, 1964

8. Henneman DH, Bunker JP, Brewster WR Jr: Immediate metabolic response to hypothermia in man. J Appl Physiol 12: 164-168, 1958

9. Wynn V: Electrolyte disturbances associated with failure to metabolize glucose during hypothermia. Lancet 2:575-578, 1954

10. Bickford AF, Mottram RF: Glucose metabolism during induced hypothermia in rabbits. Clin Science 19:345-359, 1960

11. Fuhrman FA, Crismon JM: The influence of acute hypothermia on the rate of oxygen consumption and glycogen content of the liver and on the blood glucose. Am J Physiol 149:552-560, 1947

12. Kanter GS: Renal clearance of glucose in hypothermic dogs. Am J Physiol 196:366-372, 1959

13. Vandam LD, Burnap TK: Hypothermia. N Engl J Med 261: 546-553, 595-602, 1959

14. Cassidy GJ, Dworkin S, Finney WH: The rate of action of insulin in artificially cooled mammals. Am J Physiol 73:413-416, 1925

15. Curry DL, Curry KP: Hypothermia and insulin secretion. Endocrinology 81:750-755, 1970

16. Symbas PN, Byrd BF Jr, Johnson JS, et al: Influence of hypothermia on pancreatic function. Ann Surg 154:509-516, 1961

17. Tyler DB: The effect of cooling on the mechanism of insulin action. Proc Soc Exper Biol & Med 42:278-280, 1930

18. Exton-Smith AN: Accidental hypothermia. Br Med J 4: 727-729, 1973

19. Duguid H, Simpson RG, Stowers JM: Accidental hypothermia. Lancet 2:1213-1219, 1961

20. Maclean D: Hypothermia, thrombosis, and acute pancreatitis. Br Med J 2:466, 1974

21. Postlethy JC, Dorm J: Hypothermia, thrombosis, and acute pancreatitis. Br Med J 2:446, 1974

22. Read AE, Emslie-Smith D, Gough KR, et al: Pancreatitis and accidental hypothermia. Lancet 2:1219-1221, 1961

23. Sloan REG, Hoffbrand BI: Acute pancreatitis and diabetic ketoacidosis in hypothermia. Br Med J 1:245, 1974

24. Weyman AE, Goodman RM: Severe accidental hypothermia in an alcoholic population. Am J Med 56:13-21, 1974

25. Sampson P: Sunbelt residents not immune from frostbite. JAMA 239:1605, 1978

26. Fernandez JR, O'Rourke RA, Ewy GA: Rapid active rewarming in accidental hypothermia. JAMA 212:153-156, 1970

27. Hudson LD, Conn RD: Accidental hypothermia—Associated diagnoses and prognosis in a common problem. JAMA 227:37-40, 1974

28. Laufman H: Profound accidental hypothermia. JAMA 147:1201-1212, 1951

29. Freinkel N, Singer DL, Arky RA, et al: Alcohol hypoglycemia—I. Carbohydrate metabolism of patients with clinical alcohol hypoglycemia and the experimental reproduction of the syndrome with pure ethanol. J Clin Invest 42:1112-1133, 1963

30. O'Keefe SJD, Marks V: Lunchtime gin and tonic a cause of reactive hypoglycemia. Lancet 1:1286-1288, 1977

31. Tucker HSG, Porter WB: Hypoglycemia following alcoholic intoxication. Am J Med Sci 204:559-566, 1942

32. Cahill GF Jr: Starvation in man. N Engl J Med 282:668-675, 1970

33. Fajans SS, Floyd JC: Fasting hypoglycemia in adults. N Engl J Med 294:766-772, 1976